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**OPTICAL SIGNAL TRANSMISSION BOARD AND APPARATUS** (English)

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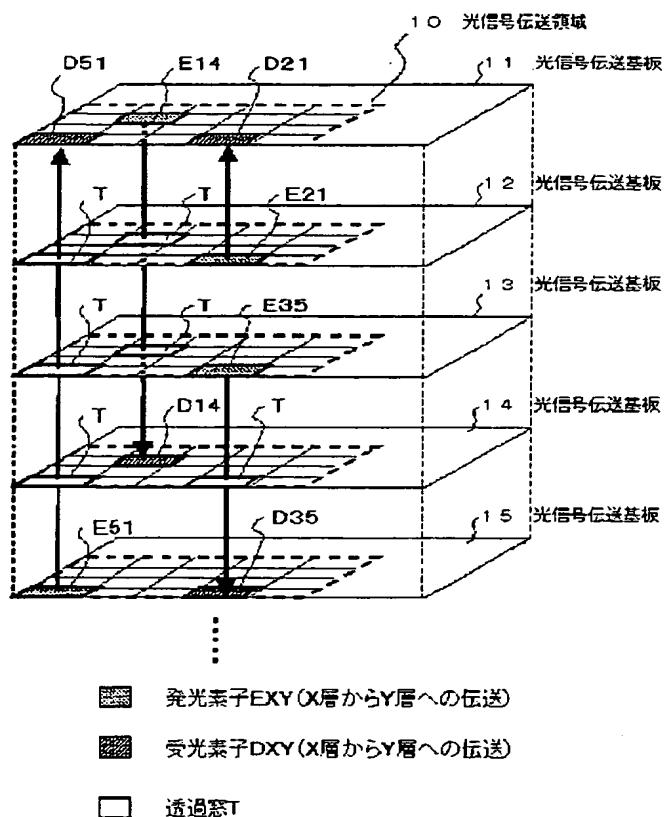
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BOARD AND DEVICE



ABSTRACT : PROBLEM TO BE SOLVED: To provide a board and a device for transmitting optical signals which can lessen man-hours required for wiring and the cost required for wiring.

SOLUTION: Individual optical signal transmitting boards 11-15 are equipped with optical signal transmission regions, in each of which at least one side between a light emitting element which transmits an optical signal to other optical transmitting boards 11-15 and a light receiving element D which receives the optical signal from the other optical signal transmitting boards 11-15 is arranged capable of transmitting/receiving the optical signal in the direction substantially vertical to the board face. When stacking a plurality of these boards, a light receiving element is arranged in one of the other optical signal transmitting boards 11-15, so that it is counterposed to the light emitting element provided in one of the optical signal transmitting boards.

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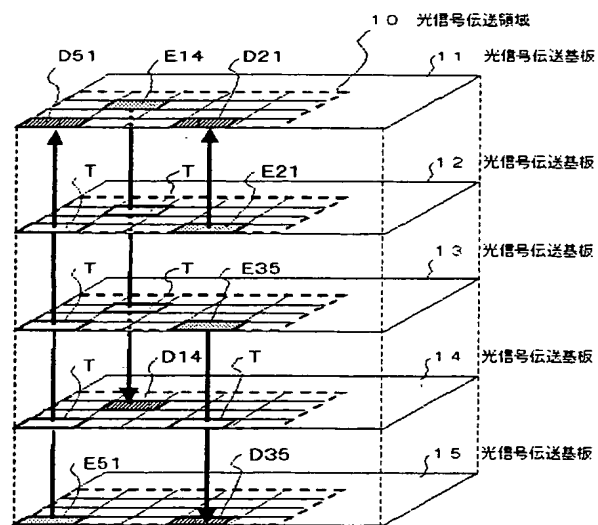
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(54) 【発明の名称】 光信号伝送基板および装置

(57) 【要約】

【課題】 配線作業に要する工数や配線にかかるコストを無くすことが可能な光信号伝送基板および装置を提供する。

【解決手段】 個々の光信号伝送基板1は、光信号を他の光信号伝送基板に送信する発光素子Eと他の光信号伝送基板からの光信号を受信する受光素子Dとの少なくとも一方が、基板面に略垂直な方向における光信号を送受信可能に配置された光信号伝送領域100を備えている。この基板を複数積層する際に、いずれかの光信号伝送基板に設けられた発光素子に対して対向するように、他のいずれかの光信号伝送基板に受光素子を配置して光信号伝送装置を構成する。



-  発光素子EXY (X層からY層への伝送)
-  受光素子DXY (X層からY層への伝送)
-  透過窓T

## 【特許請求の範囲】

【請求項1】 光信号を伝送するための光信号伝送基板であって、

光信号を他の光信号伝送基板に送信する発光素子と他の光信号伝送基板からの光信号を受信する受光素子との少なくとも一方が、当該基板面に略垂直な方向における光信号を送受信可能に配置された光信号伝送領域を備えていることを特徴とする光信号伝送基板。

【請求項2】 他の前記光信号伝送基板の間に挟まれて使用される請求項1に記載の光信号伝送基板において、前記光信号伝送領域は、他の前記光信号伝送基板の間で伝送される光信号が通過する位置に光透過性のある透過窓を備えている光信号伝送基板。

【請求項3】 少なくとも基板の一对の端部に電極を備えている請求項1に記載の光信号伝送基板。

【請求項4】 請求項1乃至請求項3のいずれかに記載の光信号伝送基板を各基板の光信号伝送領域が重なるように複数積層して構成される光信号伝送装置において、いずれかの光信号伝送基板に設けられた前記発光素子に対して対向するように、他のいずれかの光信号伝送基板に前記受光素子が配置されていることを特徴とする光信号伝送装置。

【請求項5】 前記発光素子が設けられた光信号伝送基板と前記受光素子が配置された光信号伝送基板との間に挟まれる光信号伝送基板において、当該発光素子と当該受光素子との間で伝送される光信号が通過する位置に光透過性のある透過窓を備えている請求項4に記載の光信号伝送装置。

【請求項6】 一の光信号の光軸上に当該光信号を伝送する前記発光素子と前記受光素子とからなる組が複数配置されている請求項4に記載の光信号伝送装置。

【請求項7】 前記光信号伝送基板の間に両基板の電極を電気的に接続する電極と接着剤とで構成される接着層を備えている請求項4に記載の光信号伝送装置。

## 【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は入出力情報を光信号とした光信号伝送基板に係る。特に、電子計算機など高密度実装に適した基板およびそれを利用した光信号伝送装置に関する。

【0002】

【従来の技術】従来、電子計算機などの装置では、回路を構成するために必要な複数の基板をケーブルやワイヤといった導電線による電気配線で相互に接続していた。基板の間で送受信される信号はインターフェース素子が生成する電気信号であった。

【0003】一部の装置では、一方の基板上に発光素子を設け他方の基板上に受光素子を設けて相互の素子を光ファイバで連結した光信号伝送も実現されている。

【0004】

【発明が解決しようとする課題】導電線による接続では、配線容量と配線抵抗が存在し信号遅延が生ずるため、高速度高密度実装の装置における基板間配線には向かなかった。配線抵抗により発熱を生ずるという不都合もあった。

【0005】光ファイバを利用した接続では、バスのような多数配線ではファイバ本数が多くなり、配線工数が膨大なものとなり、かつ、配線に要するコストも上昇せざるを得ない。

【0006】この不都合に対応するために、本発明は、配線作業に要する工数や配線にかかるコストを無くし、高密度実装であって高速度通信を可能とする光信号伝送基板およびその装置を提供することを目的とする。

【0007】

【課題を解決するための手段】本発明によれば、光信号を伝送するための光信号伝送基板であって、光信号を他の光信号伝送基板に送信する発光素子と他の光信号伝送基板からの光信号を受信する受光素子との少なくとも一方が、当該基板面に略垂直な方向における光信号を送受信可能に配置された光信号伝送領域を備えていることを特徴とする光信号伝送基板である。

【0008】他の光信号伝送基板の間に挟まれて使用される場合には、光信号伝送基板の光信号伝送領域は、他の光信号伝送基板の間で伝送される光信号が通過する位置に光透過性のある透過窓を備えるように構成する。

【0009】光信号伝送基板には、少なくとも基板の一对の端部に電極を備えていることが好ましい。

【0010】本発明は、上記したような光信号伝送基板を各基板の光信号伝送領域が重なるように複数積層して構成される光信号伝送装置であって、いずれかの光信号伝送基板に設けられた発光素子に対して対向するように、他のいずれかの光信号伝送基板に受光素子が配置されていることを特徴とする光信号伝送装置である。

【0011】この光信号伝送装置において、発光素子が設けられた光信号伝送基板と受光素子が配置された光信号伝送基板との間に挟まれる光信号伝送基板において、当該発光素子と当該受光素子との間で伝送される光信号が通過する位置に光透過性のある透過窓を備えていることが好ましい。

【0012】高密度通信を可能にするには、一の光信号の光軸上に当該光信号を伝送する発光素子と受光素子とからなる組を複数配置することが好ましい。

【0013】基板を積層するために、光信号伝送装置は、光信号伝送基板の間に両基板の電極を電気的に接続する電極と接着剤とで構成される接着層を備えていることが好ましい。

【0014】

【発明の実施の形態】次に本発明の実施の形態を、図面を参照して説明する。

(実施形態1) 図1に本実施形態1における光信号伝送

装置の構成を説明する斜視図を示す。図2に当該光信号伝送基板の平面図を示す。

【0015】本実施形態の光信号伝送装置は、図1に示すように、光信号伝送基板1を各基板の光信号伝送領域100が平面図上で重なるように複数積層して構成されている。図1では説明を簡単にするまでに5層の積層構造を示してあるが、層の数に限定はない。図1では第1層から第5層迄の各光信号伝送基板1を11～15と符号付けしてある。光信号伝送基板間の距離は、発光素子と受光素子間で光信号の伝送が可能な距離以内であればよい。複数の基板を直接接触させて重ねても間にスペーサを介して重ねても接着層を介して重ねてもよい。

【0016】各光信号伝送基板11～15において、いずれかの光信号伝送基板1に設けられた発光素子E<sub>XY</sub>に対向して、他のいずれかの光信号伝送基板1の受光素子D<sub>XY</sub>が配置されている。ここで「E<sub>XY</sub>」は第X層の基板から第Y層への光信号伝送をするための発光素子であることを意味する。「D<sub>XY</sub>」は第X層の基板から第Y層へ伝送される光信号を受信するための受光素子であることを意味する。発光素子E<sub>XY</sub>と受光素子D<sub>XY</sub>との組み合わせで一的光信号の送受信を行う経路を「チャンネル」と称する。同一チャンネルに属する発光素子と受光素子は、いずれかの基板の光信号伝送領域100において同一の行と列に配置されることになる。以下、行と列で特定される光信号伝送領域の位置を「アドレス」と称する。

【0017】具体的には、発光素子E<sub>XY</sub>が設けられた光信号伝送基板1と受光素子D<sub>XY</sub>が配置された光信号伝送基板1との間において、当該発光素子E<sub>XY</sub>と受光素子D<sub>XY</sub>とが対向して光信号を送受信可能に配置される。発光素子が設けられる基板と受光素子が設けられる基板との間に光信号伝送基板1が挟まれている場合には、挟まれている光信号伝送基板1は他基板の発光素子E<sub>XY</sub>と受光素子D<sub>XY</sub>との間で伝送される光信号が通過する位置に光透過性のある透過窓Tを備えるように構成されている。透過窓Tは、光信号伝送領域100において当該発光素子E<sub>XY</sub>や受光素子D<sub>XY</sub>と同一アドレスに配置されることになる。

【0018】図1において、光信号伝送基板11上の発光素子E<sub>14</sub>（第1層から第4層への光信号伝送）と光信号伝送基板14上の受光素子D<sub>14</sub>（第1層からの光信号を第4層で受信）とが対向している。両素子の間に挟まれる光信号伝送基板12と13には、光軸の通過位置に透過窓Tが設けられている。同様に光信号伝送基板15上の発光素子E<sub>51</sub>と光信号伝送基板11上の受光素子D<sub>51</sub>とが対向している。両基板間に挟まれる光信号伝送基板12～14には、光軸と基板面との交差位置に透過窓Tが設けられている。

【0019】本発明では、一的光信号の光軸上に当該光信号を伝送する発光素子と受光素子とからなる組を複数

配置することが好ましい。高密度通信を可能にするからである。光信号伝送領域100の同一の行と列において複数チャンネルが存在する場合である。図1では、光信号伝送基板12上の発光素子E<sub>21</sub>と光信号伝送基板11上の受光素子D<sub>21</sub>とからなる組と、光信号伝送基板13上の発光素子E<sub>35</sub>と光信号伝送基板15上の受光素子D<sub>35</sub>とからなる組とが同一光軸上、つまり光信号伝送領域100において同一アドレスに配置されている。

【0020】光信号伝送装置を構成する個々の光信号伝送基板1は、図2に示すように、回路領域110の一部に光信号伝送領域100を備えて構成されている。光信号伝送領域100には、光信号を他の光信号伝送基板に送信する発光素子E<sub>XY</sub>と、他の光信号伝送基板からの光信号を受信する受光素子D<sub>XY</sub>と、の少なくとも一方が、当該基板面に略垂直な方向における光信号を送受信可能に配置している。さらに光信号伝送基板が他の基板の間に挟まれて使用される場合には、光信号伝送領域100には、他の光信号伝送基板の間で伝送される光信号が通過する位置に光透過性のある透過窓Tが存在するように構成されている。

【0021】光信号伝送基板1の材質や厚みに限定はない。ただし基板が積層された場合に基板上に設けられている電子素子が他基板に接触しないように、例えば周囲にバンクやスペーサを設けるなどすることは好ましい。回路領域110に設ける回路の形態や形成方法についても限定はない。ただしバンクやスペーサなどで規定される部品の最大高さを超えないように回路の部品が配置される必要がある。具体的には、電子計算機のプロセッサ回路やメモリ回路、TFT素子の集積回路など任意の回路を適用可能である。発光素子E<sub>XY</sub>は、電流または電圧などの電気信号を光信号に変換可能な素子であり、半導体レーザ（レーザダイオード）、発光ダイオード、有機EL素子などの任意の発光素子を適用可能である。受光素子D<sub>XY</sub>は、受光した光信号を電圧または電流などの電気信号に変換可能な素子であり、フォトトランジスタやフォトダイオードなどの光電変換素子を使用可能である。

【0022】光信号伝送領域100は、発光素子E<sub>XY</sub>や受光素子D<sub>XY</sub>、透過窓Tが規則的に配置可能な領域である。例えば光信号伝送領域100は格子状に区分けされ、発光素子E<sub>XY</sub>や受光素子D<sub>XY</sub>、透過窓Tがその区分けに合わせて配置される。光信号伝送領域100は、任意の位置に発光素子E<sub>XY</sub>や受光素子D<sub>XY</sub>を配置可能な程度の強度を備える材料で構成すればよい。

【0023】例えば、光信号伝送領域100を透明樹脂からなる層で形成することが可能である。透明樹脂を基本的な材料として使用し発光素子や受光素子を配置した場合には、素子以外の部分は光透過性を備えることになるので、積極的に透過窓Tを設ける必要がなくなる。

【0024】光信号伝送領域100を光透過性のない材

料、例えば回路領域110と同一材料で形成した場合には、透過窓Tに相当する位置を開口させるか、樹脂やガラスで光が透過可能な窓を形成する。

【0025】光信号伝送領域100の格子数（最大チャネル数）は、基板間で必要な信号のチャネル数に対応して定める。光信号伝送領域100の位置は、基板上の任意の領域でよく、方形である他、直線状、円状等任意の形状で配置されるものでもよい。また、回路領域110内に互いに離間させて点状に分散させ、他の回路と混在して配置されていてもよい。回路領域110の面積を必要以上に減少させることの無いように光信号伝送領域を妥当な面積に設定する。

【0026】図3に、光信号伝送領域100が縦5×横4の格子による合計20チャネルで構成される場合の、発光素子EXYや受光素子DXY、透過窓Tの配置例を示す。発光素子EXY、受光素子DXYまたは透過窓Tのいずれにも該当しない領域は、光透過性があっても無くてもよい領域である。第1層から第5層までの光信号伝送基板11～15に対応する光信号伝送領域をそれぞれ101～105と符号付けしてある。矢印は、図左側一列における光信号の伝送経路を示している。図面では、発光素子EXYからの射出光が理想的な直進性を備えるものとし、受光素子DXYを隣接して配置してあるが、射出光の直進性があまり良くない発光素子を用いる場合には、発光素子や受光素子が隣接しないように配置したり、各光信号伝送領域の境界部分にクラッドとして機能する層を設けたりすることで、クロストークの発生を防止する必要がある。

【0027】上記光信号伝送基板に製造方法には種々のものが適用可能である。

【0028】例えば、ガラス等の透明基板上にレーザ光などによりアブレーションを生ずる剥離層を設け、その剥離層上に本発明の光信号伝送基板を所定のパターンで形成する。次いでこの光信号伝送基板を接着剤で他の光信号伝送基板と接着した後、剥離層に透明基板側から光を照射して剥離を生じさせ、透明基板を剥離する。この工程を光信号伝送基板の積層数だけ繰り返していく。

【0029】または複数の透明基板上に剥離層を介してこの光信号伝送基板を形成した後、二つの光信号基板を貼り合わせる。次いで少なくとも一方の透明基板側からレーザ光を照射して剥離層から透明基板を剥離する。透明基板を剥離した面に他の透明基板上に形成されていた光信号伝送基板を貼り合せ、その透明基板側からレーザ光を照射して透明基板を剥離する。このような工程を光信号伝送基板の積層数だけ繰り返していく。

【0030】これらのような製造方法により極めて薄い光信号伝送基板であっても確実に多数積層していくことが可能である。ただしこの製造方法に限定されるものではない。

【0031】上記実施形態1によれば、基板の一部に基

板面に略垂直方向に光信号を送受信するための光信号伝送領域を設けたので、発光素子や受光素子の配置を適正にして基板を積層するだけの簡単な基板間の信号送受信方法を提供可能である。

【0032】上記実施形態1によれば、導電性を用いることが無いので、配線容量や配線抵抗による信号遅延や配線抵抗による発熱を生じることがない。

【0033】上記実施形態1によれば、光ファイバで基板間を接続する必要が無いので、接続に要する労力と光ファイバにかかるコストを削減可能である。

【0034】上記実施形態1によれば、隣接した多層基板間の信号伝送を容易に多チャネルで実現できるので、高密度、高速度の電子計算機やTFTを用いた装置の信号伝送方法として最適である。

【0035】上記実施形態1によれば、光信号による送受信を用いるので、ノイズに強く、不要輻射を発生しない伝送装置を提供できる。

（実施形態2）本発明の実施形態2は、実施形態1において電源電極や接地電極をさらに設けた光信号伝送基板および装置に関する。

【0036】図4に本実施形態2における光信号伝送装置の構成を説明する斜視図を示す。図5に当該光信号伝送基板の平面図を示す。

【0037】本実施形態2の光信号伝送装置は、図4に示すように、光信号伝送基板2を各基板の光信号伝送領域100が平面図上で重なるように複数積層して構成される。本光信号伝送装置は、基板間に接着層3を備えている点で上記実施形態1と異なる。図4では説明を簡単にするために3層の積層構造を示してあるが、積層の数に限定はない。図4において、第1層から第3層迄の各光信号伝送基板2を21～23と符号付けする。

【0038】接着層3は、接着剤30で対向する第1電極31と第2電極32と基板2とを接着固化させて構成される。接着剤30としては、任意の樹脂、例えば反応性硬化型接着剤、熱硬化型接着剤、紫外線硬化型接着剤等の光硬化型接着剤、嫌気硬化型接着剤等の各種硬化型接着剤が挙げられ得る。このような接着剤の組成としては、例えば、エポキシ系、アクリレート系、シリコン系等いかなる接着剤でも適用することが可能である。第1電極31と第2電極32としては、アルミや銅、金など任意の金属を使用可能である。接着層3は、第1電極31や第2電極32に相当する形状の金属棒を接着剤で固めることで形成される。

【0039】本光信号伝送装置を構成する各光信号伝送基板2は、図5に示すように、上記実施形態1と同様の回路領域110と光信号伝送領域100とを備えている。ただし、少なくとも基板の一方の端部に第1電極121と第2電極122とを備えている点で実施形態1と異なる。第1電極121と第2電極122とについては、回路領域110に使用する配線材料と同一材料でバ

ターン形成するのが便利である。ただし接着層3の間に挟まれる光信号伝送基板である場合には、基板の表裏面間で電件を有するように電極が形成されていることを要する。

【0040】各光信号伝送基板21～23における光信号伝送領域100内における発光素子E X Y、受光素子D X Yおよび透過窓11の配置や構成については前記実施形態1と同様である。

【0041】図6に本実施形態の光信号伝送装置の側面図を示す。各光信号伝送基板21～23の第1電極121と接着層3の第1電極31とが電気的に接触し、各光信号伝送基板21、23の第2電極122と接着層3の第2電極32とが電気的に接触して構成されている。光信号伝送基板2と接着層3とを交互に積層することで、当該光信号伝送装置は電源電圧や接地電極が共通に配線されるようになっている。

【0042】本実施形態の光信号伝送装置の製造方法は種々に考えられる。

【0043】光信号伝送基板2が十分に厚く可搬性がある場合には、

- 1) 光信号伝送基板2上に第1電極31および第2電極32を接続し、上記の樹脂を塗布して接着層3を形成
- 2) この接着層3の上に再び光信号伝送基板2を貼り合せ、その上に再び接着層3を形成
- 3) これらの工程を必要回数繰り返して光信号伝送装置を構成

という過程で光信号伝送基板を製造可能である。

【0044】光信号伝送基板2がごく薄くそれ自体に可搬性がない場合には、

- 1) ガラス等の基台1に剥離層を形成
- 2) 剥離層の上に光信号伝送基板2に相当する回路形成
- 3) 光信号伝送基板2ができたら接着層3をその上に形成
- 4) 基台の裏からレーザ光などを照射して剥離層から剥離を生じさせ、光信号伝送基板2と接着層3とからなる組み合わせを分離
- 5) この組み合わせを必要総数重ねて光信号伝送装置を構成

という過程で光信号伝送基板を製造可能である。接着層3を形成する前にレーザ光を照射し、接着層3形成後に力を加えて剥離層から分離させてもよい。

【0045】本実施形態2によれば、上記実施形態1と同様の効果を奏する他、基板に電極を共通に設けたので、電源や接地端との接続が容易である。

【0046】本実施形態2によれば、基板間を接着層で貼り合わせるようにしたので、多層積層構造の形成が容易であり、強固な光信号伝送装置を提供可能である。

(実施形態3) 本発明の実施形態3は、実施形態2における光信号伝送基板の変形例に関する。

【0047】図7に本実施形態3における光信号伝送基板の平面図を示す。本実施形態3の光信号伝送基板4は、図7に示すように、第1電極421および第2電極422が光信号伝送領域400および回路領域410に入り込んだ複雑なパターンをしている。この電極パターンの形成は、光信号伝送基板4における電極パターンを光信号伝送領域400や回路領域410で必要とされる形状にパターンニングして通常用いられる配線パターンの形成方法を適用して実施される。

【0048】この光信号伝送基板4を用いた光信号伝送装置の構成については、上記実施形態1や2と同様に発光素子E X YやD X Yを配置すればよい。基板の接着に実施形態2の接着層3を用いることも可能である。

【0049】本実施形態3によれば、上記実施形態1と同様の効果を奏する他、基板の電極をパターンニングしたので、回路素子の電源電極や接地電極との接続が容易となり不要輻射対策としても有効である。

(実施例) 上記実施形態2における実施例として図8の平面図に示すような光信号伝送基板をシミュレーションした。第1電極121を電源(Vdd)電極とし第2電極122を接地(GND)電極にした。光信号伝送領域100の行方向(X軸方向)に電源を供給するXドライバ回路111、光信号伝送領域100の列方向(Y軸方向)を選択するYドライバ回路112を設けた。回路領域には、メモリ回路114を備えたロジック回路113を設けた。ロジック回路113としてはTFTを集積した。実施例の仕様は以下の通りである。

基板の積層数	1000枚
基板と接着層の厚み	約10μm/組
アドレス数(窓数)	1000枚×約10 <sup>6</sup> (基板当たりの集積個数)
アドレスの面積	50×50μm <sup>2</sup> =2.5×10 <sup>3</sup> μm <sup>2</sup>
光信号伝送領域面積	アドレス面積×集積個数=25cm <sup>2</sup>
光信号伝送基板外形	7cm(縦)×14cm(横)=98cm <sup>2</sup>
面積当たりの製造原価	¥20/cm <sup>2</sup>
基板当たりの製造原価	¥2000
装置の製造原価	¥2000000
TFT 1個の面積	4μm <sup>2</sup>
基板当たりのTFT数	約9×10 <sup>8</sup> 個=1G個

(その他の変形例) 本発明は、上記実施形態に限定され

ることなく種々に変形して適用が可能である。例えば光

信号伝送基板や光信号伝送領域、電極の外形や光信号伝送領域の配置は一例に過ぎない。

【0050】光信号伝送装置は、光信号の光軸に垂直な面に平行に重ねた場合に光信号伝送領域が各アドレスを一致させて重なれば十分であり、基板自体が重なっていることを要しない。例えば図9に示すように、各基板で光信号伝送領域の配置が異なっている、当該領域さえ正しく重なっていれば信号伝送が可能である。

【0051】

【発明の効果】本発明によれば、積層される基板に光信号伝送領域を設け、基板間に光信号の伝送を可能とする発光素子と受光素子との組を設けたので、配線作業に要する工数や配線にかかるコストを無くすることが可能である。このような構成により、高密度実装であって高速度通信を可能とすることができる。

【図面の簡単な説明】

【図1】実施形態1における光信号伝送装置の構成を説明する斜視図である。

【図2】実施形態1における光信号伝送基板の平面図である。

【図3】実施形態1における発光素子と受光素子の組み

合わせ説明図である。

【図4】実施形態2における光信号伝送装置の構成を説明する斜視図である。

【図5】実施形態2における光信号伝送基板の平面図である。

【図6】実施形態2における光信号伝送装置の側面図である。

【図7】実施形態3における光信号伝送基板の平面図である。

【図8】実施例の光信号伝送基板の平面図である。

【図9】光信号伝送装置の積層方法の変形例である。

【符号の説明】

E…発光素子

D…受光素子

T…透過窓

1, 11~15、2, 21~25、4…光信号伝送基板

3…接着層

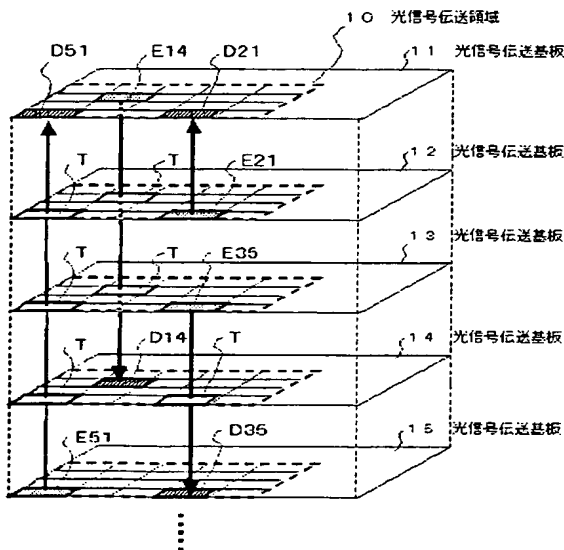
100~105…光信号伝送領域

110…回路領域

121、31…第1電極

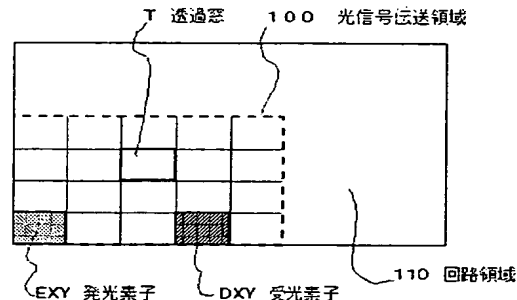
122、32…第2電極

【図1】



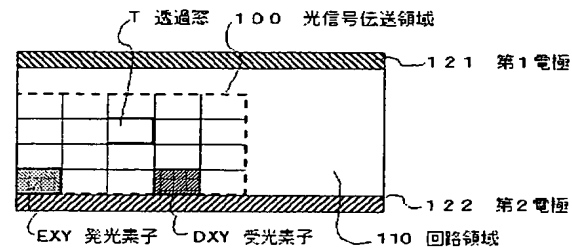
- 発光素子EXY (X層からY層への伝送)
- ▨ 受光素子DXY (X層からY層への伝送)
- 透過窓T

【図2】



1: 光信号伝送基板

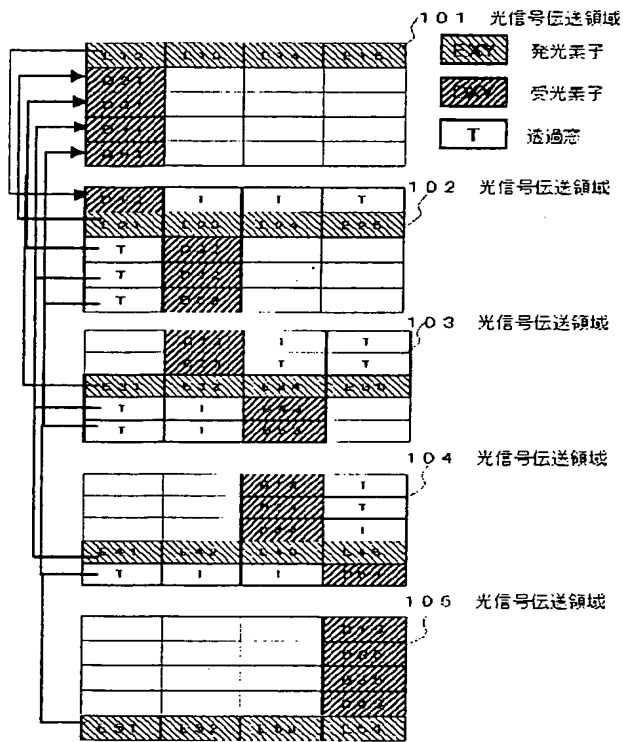
【図5】



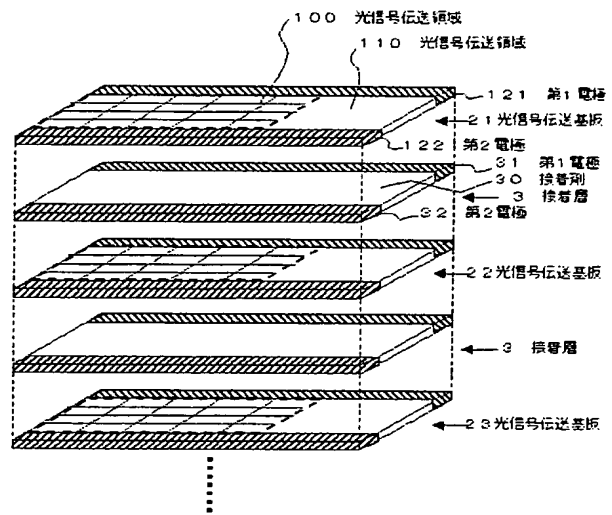
2: 光信号伝送基板



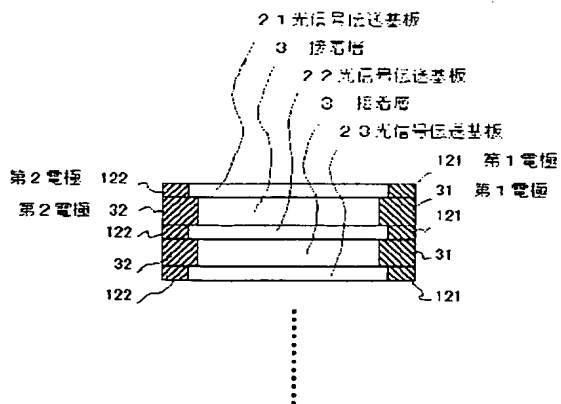
【図3】



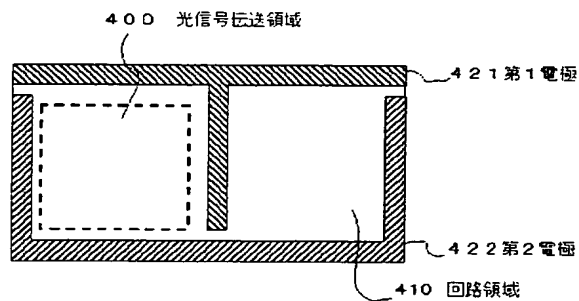
【図4】



【図6】

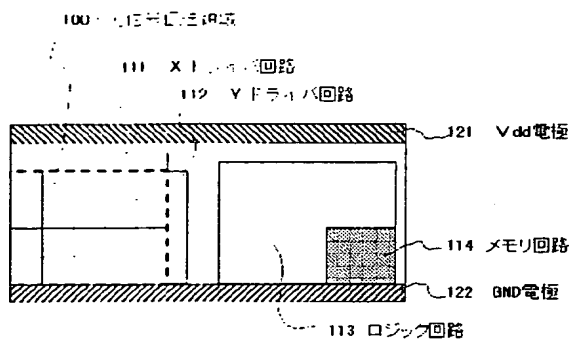


【図7】



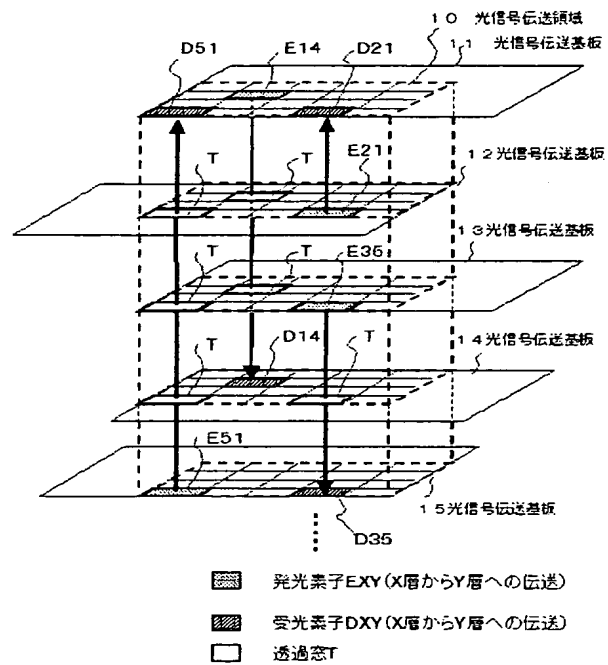
4: 光信号伝送基板

【図8】



光信号伝送基板

【図9】



フロントページの続き

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Continued to last page

(54) [Title of the Invention] OPTICAL SIGNAL TRANSMITTING SUBSTRATE AND DEVICE

30 (57) [Abstract]

[Object] To provide a substrate and a device for transmitting optical signals which can lessen man-hours required for wiring and the cost required for wiring.

[Means for Solution] Individual optical signal transmitting substrates 1 are equipped with optical signal transmitting regions 100, in each of which at least one of a light emitting element E which transmits an optical signal to other optical signal transmitting substrates and a photo-detecting element D which receives an optical signal from other optical signal transmitting substrates is arranged capable of transmitting/receiving the optical signal in the direction substantially vertical to the substrate face. When stacking a plurality of these substrates, a photo-detecting element is arranged in one of the other optical signal transmitting substrates, so that it is counterposed to a light emitting element provided in one of the optical signal transmitting substrates.

[Scope of Claims]

[Claim 1] An optical signal transmitting substrate for transmitting optical signals characterized by comprising an optical signal transmitting region in which at least one of a light emitting element which transmits an optical signal to other optical signal transmitting substrates and a photo-detecting element which receives an optical signal from other optical signal transmitting substrates is arranged capable of transmitting/receiving the optical signal in the direction substantially vertical to the substrate face.

[Claim 2] The optical signal transmitting substrate in accordance with Claim 1 which is used with being sandwiched between other optical signal transmitting substrates, wherein the optical signal transmitting region is equipped with a transparent aperture with light transparency at a position through which an optical signal transmitted among other optical signal transmitting substrates passes.

[Claim 3] The optical signal transmitting substrate in accordance with Claim 1, wherein electrodes are equipped at least in a pair of edges of the substrate.

[Claim 4] An optical signal transmitting device which is configured by stacking a plurality of the optical signal transmitting substrates in accordance with any one of Claims 1 to 3 so that the optical signal transmitting regions of each substrate are

overlapped, characterized in that the photo-detecting element is arranged in one of the other optical signal transmitting substrates so that it is counterposed to the light emitting element provided in one of the optical signal transmitting substrates.

[Claim 5] In the optical signal transmitting substrate sandwiched between the optical signal transmitting substrate with which the light emitting element is provided and the optical signal transmitting substrate with which the photo-detecting element is arranged, the optical signal transmitting device in accordance with Claim 4, wherein a transparent aperture with light transparency is equipped at a position through which the optical signal transmitted between the light emitting element and the photo-detecting element passes.

[Claim 6] The optical signal transmitting device in accordance with Claim 4, wherein a plurality of groups comprised of the light emitting element and the photo-detecting element transmitting an optical signal are arranged in an optical axis of the optical signal.

[Claim 7] The optical signal transmitting device in accordance with Claim 4, wherein an adhesive layer comprised of electrodes for connecting electrodes of both substrates electrically and an adhesive is equipped between the optical signal transmitting substrates.

#### [Detailed Description of the Invention]

#### [0001]

[Technical Field of the Invention] The present invention relates to an optical signal transmitting substrate in which input-output information is an optical signal. In particular, this invention relates to a substrate which is suitable for high-density mounting and an optical signal transmitting device using it, such as an electronic computer.

#### [0002]

[Prior Art] Conventionally, in a device such as an electronic computer, a plurality of substrates required for constitution of a circuit are mutually connected by electric wiring using conductive lines such as cables and wires. The signal transmitted and received among substrates is an electrical signal generated by an interface element.

[0003] In some devices, optical signal transmission is also realized in which a light emitting element is provided on one substrate and a photo-detecting element is provided on the other substrate, and the mutual elements are connected with fiber optics.

[0004]

5 [Problem to be Solved by the Invention] The connection by using conductive lines is not suitable for wiring among substrates in the device of high-speed high-density mounting, since wiring capacity and wiring resistance exist and signal delay arises. There is also a disadvantage of producing fever by the wiring resistance.

[0005] As for connection by using fiber optics, in multiple wiring such as a bus, the  
10 number of fiber increases, man-hours of wiring are enormous and the cost required for wiring cannot but rise.

[0006] In order to deal with this disadvantage, it is an object of the present invention to lessen man-hours required for wiring and the cost required for wiring and provide a substrate and a device using it for transmitting optical signals which enable high-density  
15 mounting and high-speed communication.

[0007]

[ Means for Solving the Problems] In accordance with the present invention, an optical signal transmitting substrate for transmitting optical signals is characterized in that it is equipped with an optical signal transmitting region, in which at least one of a light  
20 emitting element which transmits an optical signal to other optical signal transmitting substrates and a photo-detecting element which receives an optical signal from other optical signal transmitting substrates is arranged capable of transmitting/receiving the optical signal in the direction substantially vertical to the substrate face.

[0008] When the optical signal transmitting substrate is used with being sandwiched  
25 between other optical signal transmitting substrates, the optical signal transmitting region of the optical signal transmitting substrate is configured so that it is equipped with a transparent aperture with light transparency at a position through which an optical signal transmitted among other optical signal transmitting substrates passes.

[0009] The optical signal transmitting substrate is preferably equipped with electrodes  
30 at least in a pair of edges of the substrate.

[0010] In accordance with the present invention, an optical signal transmitting device which is configured by stacking a plurality of the optical signal transmitting substrates as described above so that the optical signal transmitting regions of each substrate are overlapped, is characterized in that a photo-detecting element is arranged in one of the other optical signal transmitting substrates so that it is counterposed to a light emitting element provided in one of the optical signal transmitting substrates.

[0011] In this optical signal transmitting device, the optical signal transmitting substrate sandwiched between the optical signal transmitting substrate with which a light emitting element is provided and the optical signal transmitting substrate with which a photo-detecting element is arranged is preferably equipped with a transparent aperture with light transparency at a position through which the optical signal transmitted between the light emitting element and the photo-detecting element passes.

[0012] In order to realize high-density communication, a plurality of groups comprised of the light emitting element and the photo-detecting element transmitting an optical signal are preferably arranged in an optical axis of the optical signal.

[0013] In order to stacking substrates, the optical signal transmitting device is preferably equipped with an adhesive layer comprised of electrodes for connecting electrodes of both substrates electrically and an adhesive between the optical signal transmitting substrates.

[0014]

[Embodiment Mode of the Invention] Next, one embodiment of the present invention is described with reference to drawings.

(Embodiment Mode 1) FIG. 1 shows a perspective view to describe a structure of an optical signal transmitting device in Embodiment Mode 1. FIG. 2 shows a plan view of the optical signal transmitting substrate.

[0015] The optical signal transmitting device in this embodiment mode is configured by stacking a plurality of optical signal transmitting substrates 1 so that optical signal transmitting regions 100 of the substrates are overlapped in a plan view, as shown in FIG. 1. Although the laminated structure of five layers is shown in FIG. 1 to simplify description, there is no limitation in the number of layers. Each optical signal

transmitting substrate 1 from a first layer to a fifth layer is referred to as 11 to 15 in FIG.

1. A distance between the optical signal transmitting substrates is within the distance that can transmit an optical signal between a light emitting element and a photo-detecting element. A plurality of substrates may be overlapped with those  
5 contacted directly, with spacers interposed therebetween, or with adhesive layers interposed therebetween.

[0016] In each optical signal transmitting substrate 11 to 15, a photo-detecting element DXY of one of the other optical signal transmitting substrates 1 is arranged so that it is counterposed to a light emitting element EXY provided in one of the optical signal  
10 transmitting substrates 1. Here, "EXY" means a light emitting element for transmitting an optical signal from a substrate of Xth layer to that of Yth layer. "DXY" means a photo-detecting element for receiving the optical signal transmitted from the substrate of Xth layer to that of Yth layer. A path which transmits and receives one optical signal in combination of the light emitting element EXY and the  
15 receiving element DXY is called a "channel." The light emitting element and the photo-detecting element belonging to the same channel are arranged at the same row and column in the optical signal transmitting regions 100 of the substrates. Hereinafter, a position of the optical signal transmitting region specified by the row and column is called an "address."

20 [0017] Specifically, the light emitting element EXY is arranged to be counterposed to the photo-detecting element DXY between the optical signal transmitting substrate 1 with which the light emitting element EXY is provided and the optical signal transmitting substrate 1 with which the photo-detecting element DXY is arranged so that the optical signal can be transmitted and received. When the optical signal  
25 transmitting substrate 1 is sandwiched between the substrate with which the light emitting element is provided and the substrate with which the photo-detecting element is provided, the sandwiched optical signal transmitting substrate 1 is configured so that it is equipped with a transparent aperture T with light transparency at a position through which the optical signal transmitted between the light emitting element EXY and the  
30 photo-detecting element DXY in other substrates passes. The transparent aperture T is



arranged in the optical signal transmitting region 100 to the same address as the light emitting element EXY and the photo-detecting element DXY.

[0018] In FIG. 1, a light emitting element E14 on the optical signal transmitting substrate 11 (transmitting the optical signal from the first layer to the fourth layer) is counterposed to a photo-detecting element D14 on the optical signal transmitting substrate 14 (receiving the optical signal from the first layer in the fourth layer). Transparent apertures T are provided at a position through which the optical axis passes in the optical signal transmitting substrates 12 and 13 sandwiched between the both elements. Similarly, a light emitting element E51 on the optical signal transmitting substrate 15 is counterposed to a photo-detecting element D51 on the optical signal transmitting substrate 11. Transparent apertures T are provided at a position in which the optical axis intersects with the substrate faces in the optical signal transmitting substrates 12 to 14 sandwiched between the both substrates.

[0019] A plurality of groups comprised of a light emitting element and a photo-detecting element transmitting an optical signal are preferably arranged in an optical axis of the optical signal in this invention. This is because high-density communication is realized. It is a case where a plurality of channels exist in the same row and column of the optical signal transmitting regions 100. In FIG. 1, a group comprised of a light emitting element E21 on the optical signal transmitting substrate 12 and a photo-detecting element D21 on the optical signal transmitting substrate 11 and a group comprised of a light emitting element E35 on the optical signal transmitting substrate 13 and a photo-detecting element D35 on the optical signal transmitting substrate 15 are arranged in the same optical axis, that is, the same address in the optical signal transmitting regions 100.

[0020] Each optical signal transmitting substrate 1 constituting the optical signal transmitting device is equipped with the optical signal transmitting region 100 in a part of a circuit region 110, as shown in FIG. 2. In the optical signal transmitting region 100, at least one of the light emitting element EXY which transmits an optical signal to other optical signal transmitting substrates and the photo-detecting element DXY which receives an optical signal from other optical signal transmitting substrates is arranged

capable of transmitting/receiving the optical signal in the direction substantially vertical to the substrate face. Furthermore, when the optical signal transmitting substrate is used with being sandwiched between other substrates, the optical signal transmitting region 100 is configured so that a transparent aperture T with light transparency exists at a position through which an optical signal transmitted among other optical signal transmitting substrates passes.

[0021] There is no limitation in a material and thickness of the optical signal transmitting substrate 1. However, when the substrates are stacked, it is preferable to provide a bank or a spacer around so that an electronic element provided on the substrate may not contact other substrates. There is also no limitation about a form and a forming method of a circuit provided in the circuit region 110. However, components of the circuit need to be arranged so that they may not exceed the maximum height of components specified with a bank, a spacer, or the like. Specifically, any circuits such as a processor circuit and a memory circuit of an electronic computer and an integrated circuit of a TFT element are applicable. The light emitting element EXY can convert electrical signals such as a current or a voltage into an optical signal, and can apply any light emitting elements such as a semiconductor laser (a laser diode), a light emitting diode, and an organic EL element. The photo-detecting element DXY can convert a received optical signal into electrical signals such as a voltage or a current, and can use photoelectric conversion elements such as a phototransistor or a photodiode.

[0022] The optical signal transmitting region 100 is the region in which the light emitting element EXY, the receiving element DXY, and the transparent aperture T can be arranged regularly. For example, the optical signal transmitting region 100 is divided in a grid form, and the light emitting element EXY, the receiving element DXY, and the transparent aperture T are arranged in accordance with the division. The optical signal transmitting region 100 is configured by a material having the strength to the extent that the light emitting element EXY and the receiving element DXY can be arranged in any position.

[0023] For example, the optical signal transmitting region 100 can be formed using a

layer comprising transparent resin. When transparent resin is used as a basic material and the light emitting element and the receiving element are arranged, parts other than these elements have light transparency. Thus, it is not necessary to provide the transparent aperture T positively.

5 [0024] When the optical signal transmitting region 100 is formed using a material without light transparency, for example, the same material as the circuit region 110, a position corresponding to the transparent aperture T is opened, or an aperture through which light can transmit is formed.

[0025] The number of grids in the optical signal transmitting region 100 (the  
10 maximum number of channels) is defined corresponding to the number of channels of signals required between substrates. A position of the optical signal transmitting region 100 is arranged in any region on the substrate, and also the optical signal transmitting region 100 may be arranged in any shapes, such as a rectangle, a linear, and a circle. Additionally, it may be separated each to each to disperse in a point-like  
15 pattern in the circuit region 110, and arranged with being mixed with other circuits. The area of the optical signal transmitting region is appropriately set so as not to decrease the area of the circuit region 110 beyond necessity.

[0026] FIG. 3 shows an example of arrangement of the light emitting element EXY, the photo-detecting element DXY, and the transparent aperture T when the optical signal  
20 transmitting region 100 is configured by a total of 20 channels which are comprised of 5 vertical grids  $\times$  4 horizontal grids. A region applicable to none of the light emitting element EXY, the photo-detecting element DXY, nor the transparent aperture T may be with or without light transparency. Optical signal transmitting regions corresponding to optical signal transmitting substrates 11 to 15 from the first layer to the fifth layer are  
25 referred to as 101 to 105, respectively. Arrows show transmitting routes of optical signals in a column on the left hand in the figure. Injected light from the light emitting element EXY is assumed to have an ideal rectilinear propagation property and the photo-detecting element DXY is arranged adjacently in the drawing. However, when the light emitting element EXY whose rectilinear propagation property of injected light  
30 is not so good is used, it is necessary to prevent occurrence of a cross talk by arranging

the light emitting element and the photo-detecting element so that they may not be adjacent or providing a layer functioning as cladding in a boundary part between each optical signal transmitting region.

[0027] Various methods are applicable to a manufacturing method of the optical signal transmitting substrate.

[0028] For example, a release layer which produces ablation by laser light is provided on a transparent substrate such as glass, and the optical signal transmitting substrate of the present invention is formed on the release layer by a predetermined pattern. Subsequently, after bonding this optical signal transmitting substrate to another optical signal transmitting substrate with an adhesive, the release layer is irradiated with light from the transparent substrate side to produce separation and the transparent substrate is separated. This process is repeated in accordance with lamination number of the optical signal transmitting substrates.

[0029] Alternatively, after forming this optical signal transmitting substrate over a plurality of transparent substrates with a release layer interposed therebetween, two optical signal substrates are stuck together. Subsequently, laser irradiation is conducted from at least one side of the transparent substrates, and the transparent substrates are separated from the release layer. The optical signal transmitting substrate formed on another transparent substrate is stuck to the side from which the transparent substrate is separated, and laser irradiation is conducted from the transparent substrate side to separate the transparent substrate. This process is repeated in accordance with lamination number of the optical signal transmitting substrates.

[0030] A large number of optical signal transmitting substrates can be stacked certainly by using these manufacturing methods, although they are extremely thin.

However, it is not limited to these manufacturing methods.

[0031] In accordance with Embodiment Mode 1, since the optical signal transmitting region for transmitting/receiving the optical signal is arranged in one part of the substrate in a direction substantially vertical to the substrate face, a simple method for transmitting/receiving a signal between substrates to arrange the light emitting element and the photo-detecting element properly and stack substrates can be provided.

[0032] In accordance with Embodiment Mode 1, since conductivity is not used, signal delay by wiring capacity and wiring resistance and fever by writing resistance are not produced.

[0033] In accordance with Embodiment Mode 1, since there is no need to connect  
5 between substrate with fiber optics, efforts required for connection and the cost required for fiber optics can be reduced.

[0034] In accordance with Embodiment Mode 1, since signal transmission between adjacent multilayered substrates can be realized easily in multichannel, it is most suitable as a signal transmitting method of a device using an electronic computer and a  
10 TFT of high-density and high-speed.

[0035] In accordance with Embodiment Mode 1, since transmitting/receiving by an optical signal is used, a transmitting device which is strong in noise and dose not generate unnecessary radiation can be provided.

(Embodiment Mode 2) Embodiment Mode 2 of the present invention relates to an  
15 optical signal transmitting substrate and device in which power electrodes and earth electrodes are provided further in Embodiment Mode 1.

[0036] FIG. 4 shows a perspective view to describe a structure of the optical signal transmitting device in Embodiment Mode 2. FIG. 5 shows a plan view of the optical signal transmitting substrate.

[0037] The optical signal transmitting device in Embodiment Mode 2 is configured by  
20 stacking a plurality of optical signal transmitting substrates 2 so that optical signal transmitting regions 100 of each substrate are overlapped in plan views, as shown in FIG. 4. This optical signal transmitting device is different from the one in Embodiment Mode 1 in that it has an adhesive layer 3 between substrates. Although  
25 the laminated structure of three layers is shown in FIG. 4 to simplify description, there is no limitation in the number of layers. Each optical signal transmitting substrate 2 from a first layer to a third layer is referred to as 21 to 23 in FIG. 4.

[0038] The adhesive layer 3 is configured by bonding and solidifying a first electrode  
30 31 and a second electrode 32 counterposed with an adhesive 30 interposed therebetween and the substrate 2. Any resins, for example, various hardening type adhesives such as

a reactive curing type adhesive, a thermosetting adhesive, a photo-curing type adhesive such as an ultraviolet curable adhesive, and an aversion hardening type adhesive can be given as the adhesive 30. Any adhesives such as an epoxy system, an acrylate system, and a silicon system can be applied as composition of such adhesives. Any metals  
5 such as aluminum, copper, and gold can be used as the first electrode 31 and the second electrode 32. The adhesive layer 3 is formed by hardening a metal rod whose shape corresponds to the first electrode 31 and the second electrode 32 with adhesives.

[0039] Each optical signal transmitting substrate 2 constituting this optical signal transmitting device is equipped with the same circuit region 110 and optical signal  
10 transmitting region 100 as Embodiment Mode 1, as shown in FIG. 5. However, it is different from Embodiment Mode 1 in that it is equipped with a first electrode 121 and a second electrode 122 at least in a pair of edges of the substrate. As for the first electrode 121 and the second electrode 122, it is convenient to conduct pattern formation using the same material as the wiring material used in the circuit region 110.

15 However, in the optical signal transmitting substrate sandwiched between adhesive layers 3, electrodes are required to be formed so that the substrate may have conductivity between top/back faces of the substrate.

[0040] Arrangement and a configuration of a light emitting element EXY, a photo-detecting element DXY, and a transparent aperture T in the optical signal  
20 transmitting region 100 in each optical signal transmitting substrate 21 to 23 are the same as those of Embodiment Mode 1.

[0041] FIG. 6 shows a side view of the optical signal transmitting device in this embodiment mode. First electrodes 121 of each optical signal transmitting substrate 21 to 23 and first electrodes 31 of the adhesive layer 3 contact electrically, and second  
25 electrodes 122 of each optical signal transmitting substrate 21 to 23 and second electrodes 32 of the adhesive layer 3 contact electrically. By stacking the optical signal transmitting substrate 2 and the adhesive layer 3 alternately, power electrodes and earth electrodes are wired mutually in this optical signal transmitting device.

[0042] Manufacturing methods of the optical signal transmitting device in this  
30 embodiment mode are conceivable variously.

[0043] When the optical signal transmitting substrate 2 is thick enough and has portability, the optical signal transmitting substrate can be manufactured in following processes.

1) The first electrode 31 and the second electrode 32 are connected on the optical signal transmitting substrate 2, and the resin is applied to form the adhesive layer 3.

2) The optical signal transmitting substrate 2 is stuck again on this adhesive layer, and the adhesive layer 3 is formed again thereon.

3) The optical signal transmitting device is configured by repeating these processes in accordance with required number.

[0044] When the optical signal transmitting substrate 2 is extremely thin and has no portability in itself, the optical signal transmitting substrate can be manufactured in following processes.

1) A release layer is formed on a base such as glass.

2) A circuit corresponding to the optical signal transmitting substrate 2 is formed on the release layer.

3) When the optical signal transmitting substrate 2 is formed, the adhesive layer 3 is formed thereon.

4) The release layer is irradiated with laser light from a back side of the base to produce separation and a combination comprised of the optical signal transmitting substrate 2 and the adhesive layer 3 is separated.

5) The optical signal transmitting device is configured by stacking this combination in accordance with required total number.

Laser irradiation is conducted before forming the adhesive layer 3, and after forming the adhesive layer 3, it may be separated from the release layer by adding a force.

[0045] Embodiment Mode 2 has the same effect as Embodiment Mode 1, and also it can be easily connected to a power source and an earth terminal since electrodes are provided mutually on substrates.

[0046] In accordance with Embodiment Mode 2, since the substrates are stuck together by the adhesive layer, the multilayered laminated structure is formed easily and the strong optical signal transmitting device can be provided.

(Embodiment Mode 3) Embodiment Mode 3 of the present invention relates to a transformed example of the optical signal transmitting substrate in Embodiment Mode 2.

[0047] A plan view of the optical signal transmitting device in Embodiment Mode 3 is shown in FIG. 7. An optical signal transmitting substrate 4 in Embodiment Mode 3 has a complicated pattern of a first electrode 421 and a second electrode 422 getting into an optical signal transmitting region 400 and a circuit region 410, as shown in FIG. 7. Formation of this electrode pattern is conducted by patterning an electrode pattern in the optical signal transmitting substrate 4 to a shape required for the optical signal transmitting region 400 and the circuit region 410 and applying a forming method of a wiring pattern which is usually used.

[0048] As for a configuration of the optical signal transmitting device using this optical signal transmitting substrate 4, a light emitting element EXY and a DXY is arranged same as Embodiment Modes 1 and 2. The adhesive layer 3 of Embodiment Mode 2 can be used for adhesion of substrates.

[0049] Embodiment Mode 3 has the same effect as Embodiment Mode 1. In addition, since electrodes on the substrate are patterned, connection with a power electrode and an earth electrode of a circuit element is easy and so it is effective as measures against unnecessary radiation.

(Embodiment) As an embodiment in Embodiment Mode 2, an optical signal transmitting substrate as shown in a plan view of FIG. 8 is simulated. The first electrode 121 is used as a power (Vdd) electrode, and the second electrode 122 is used as an earth (GND) electrode. An X driver circuit 111 which supplies a power source in a row direction (X-axis direction) of the optical signal transmitting region 100 and a Y driver circuit 112 which selects a column direction (Y-axis direction) of the optical signal transmitting region 100 are provided. A logic circuit 113 comprising a memory circuit 114 is provided in the circuit region. TFT is accumulated as the logic circuit 113. Specifications of the embodiment are as follows.

Lamination number of substrates: 1000

Thickness of a substrate and an adhesive layer: about 10  $\mu\text{m}$ /set



Address number (the number of apertures):  $1000 \times \text{about } 10^6$  (accumulation number per substrate)

Area of an address:  $50 \times 50 \mu\text{m}^2 = 2.5 \times 10^3 \mu\text{m}^2$

Optical signal transmitting region area: address area  $\times$  accumulation number =  $25 \text{ cm}^2$

5 Optical signal transmitting substrate outline: 7 cm (length)  $\times$  14 cm (width) =  $98 \text{ cm}^2$

Manufacturing cost per area:  $20/\text{cm}^2$  yen

Manufacturing cost per substrate: 2000 yen

Manufacturing cost of device: 2000000 yen

Area of one TFT:  $4 \mu\text{m}^2$

10 TFT number per substrate: about  $9 \times 10^8 = 1 \text{ G}$

(Other transformed examples) This invention can be applied by being transformed variously without being limited to the above-mentioned embodiment mode. For example, an optical signal transmitting substrate, an optical signal transmitting region, an external shape of electrode, and arrangement of an optical signal transmitting region  
15 is only an example.

[0050] An optical signal transmitting device is sufficient if optical signal transmitting regions are overlapped to conform each address when they are overlapped parallel to a vertical face to an optical axis of an optical signal, and it does not require that substrates in themselves are conformed. As shown in FIG. 9 for example, if arrangement of  
20 optical signal transmitting regions is different in each substrate, signal transmission is possible as long as the regions are overlapped correctly.

[0051]

[Effect of the invention] In accordance with this invention, since the optical signal transmitting region is provided on laminated substrates and groups comprised of the  
25 light emitting element and the photo-detecting element which can transmit the optical signal are provided between substrates, man-hours required for wiring and the cost required for wiring can be lessened. By such configuration, high-density mounting and high-speed communication can be realized.

[Brief Description of the Drawings]

30 [FIG. 1] A perspective view to describe a configuration of an optical signal transmitting

device in Embodiment Mode 1.

[FIG. 2] A plan view of an optical signal transmitting substrate in Embodiment Mode 1.

[FIG. 3] A drawing to describe combination of a light emitting element and a photo-detecting element in Embodiment Mode 1.

5 [FIG. 4] A perspective view to describe a configuration of an optical signal transmitting device in Embodiment Mode 2.

[FIG. 5] A plan view of an optical signal transmitting substrate in Embodiment Mode 2.

[FIG. 6] A side view of an optical signal transmitting device in Embodiment Mode 2.

[FIG. 7] A plan view of an optical signal transmitting substrate in Embodiment Mode 3.

10 [FIG. 8] A plan view of an optical signal transmitting substrate of an embodiment.

[FIG. 9] A drawing to show a transformed example of a laminating method of an optical signal transmitting device.

[Description of Signs]

E...light emitting element

15 D...photo-detecting element

T...transparent aperture

1, 11-15, 2, 21-25, 4...optical signal transmitting substrate

3...adhesive layer

100-105...optical signal transmitting region

20 110...circuit region

121, 31...first electrode

122, 32...second electrode

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25 F term (reference)

5F041 AA02 AA42 AA43 CA91 DC81

DC91 FF14 FF16

5F049 MA01 MA11 NA03 NA09 NB01

NB10 RA02 SE11 SE20 UA01

30 UA17

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